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1.2.2 The CIE Chromaticity Diagram

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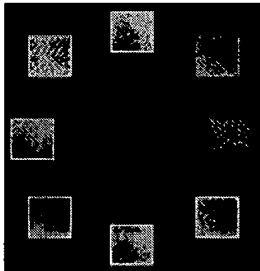
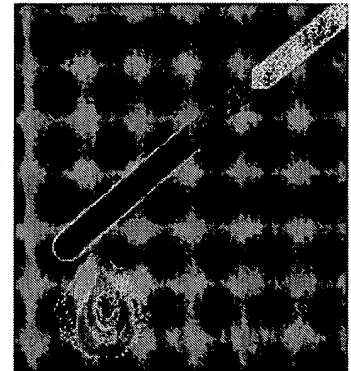
**LIGHTING
SYSTEMS**

Color Rendition

To determine the color rendering capabilities of different light sources, there are two important measurements to consider: **Color Temperature** and **Color Rendering Index**.

Color Temperature, or **Chromaticity**, is a measure in degrees Kelvin that indicates the appearance of a source. If a steel rod were placed into a fire it would first turn red, then orange as it heats up, until it finally turns bluish white. The temperatures of the rod and the color at each temperature describe the color of a source. It may sound like a contradiction, but low color temperature lamps have more red wavelengths, thus creating a warm feeling. High color temperature lamps have more blue wavelengths creating a cool feeling.

In general, the higher the light levels in a space, the cooler the source. For example, offices in the 50 to 100 footcandle range, typically use fluorescent lamps with a color temperature of 4100 degrees Kelvin. Lobby areas (10 to 20 footcandles) usually have incandescent lighting with a color temperature of 2700 degrees Kelvin.



Chromaticity doesn't tell us how well the light source renders colors, it just tells us the *apparent* color of the source - whether it provides a cool or warm feeling. The **Color Rendering Index**, or **CRI**, of a source indicates how well it renders eight standard colors compared to a perfect reference lamp of the same color temperature. The comparison is only valid for lamps of the same color temperature. The CRI Index ranges from 1 to 100. A lamp with a CRI of 80 will render colors better than a lamp with a CRI of 50.

But the CRI alone doesn't indicate color accuracy. To compare the color rendering capability of two light sources, first choose two sources with an appropriate color temperature for the situation. Then compare the CRI of each source. The higher CRI source will probably render the colors in the space more accurately.

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APOGEE

Glossary of terms

Ambient lighting: Lighting throughout an area that provides general illuminations.

Ballast: A device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, and wave form) for starting and operating.

Batwing distribution: A symmetrical light distribution producing light pattern angles to the right and left of the observer with comparatively little direct downward illumination. The shape is thus similar to that of a batwing.

Batwing lens (linear prismatic): A lens, usually of molded or extruded acrylic, consisting of a series of prisms that cause a batwing distribution of light.

Color rendering index (CRI): A method for describing the effect of a light source on the color appearance of objects being illuminated, with a CRI of 100 representing the reference condition (and thus the maximum CRI possible). In general, a lower CRI indicates that some colors may appear unnatural when illuminated by the lamp.

Color temperature (chromaticity): The degree of warmth or coolness of a light source, measured in degrees Kelvin (K). The higher the degree K, the more blue, or cooler the lamp appears. The lower the degree K, the more red, or warmer the lamp appears.

Contrast: The difference between the luminance (brightness) of the detail in a visual task and the luminance of its immediate background (e.g., between the print and the paper).

Correlated color temperature (CCT): A description of the color appearance of a light source in terms of its warmth or coolness. The CCT relates the color appearance of the light emitted by the lamp to the color appearance of the reference material heated to a high temperature (measured on the Kelvin scale, abbreviated K). As the temperature rises, the color appearance shifts from yellow to blue. Thus, lamps with a low CCT (3000 degrees K or less) have a yellow-white color appearance and are described as "warm"; lamps with a high CCT (4000 degrees K or higher) have a blue-white color appearance and are described as "cool".

Diffuser: A device to redirect or scatter the light from a source, primarily by the process of diffuse transmission.

Direct glare: Glare resulting from the excessive brightness or insufficiently shielded light sources in the field of view.

Electric-discharge lamp: A lamp in which light is produced by passing an electric current through a gas. These lamps may be named after the gas they contain, as in mercury lamps, sodium lamps, neon lamps; or they may be named for their operating parameters or dimensions, as in short arc lamps, high pressure lamps, etc.

Fluorescent lamp: A low pressure mercury, electric-discharge lamp in which phosphor coating transforms ultraviolet energy (created by electric discharge) into visible light.

Fixture: A complete lighting unit consisting of a lamp or lamps together with parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Footcandle (fc): A unit of measurement indicating how much illumination is reaching a surface. It is equal to one lumen striking an area of one square foot.

General lighting: Lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special local requirements.

Glare: A sensation caused by light within the visual field that is brighter than the level of light to which the eyes are adapted, causing annoyance, discomfort or loss in visual performance.

Illuminance: The amount of light that reaches a surface. Illuminance is measured in footcandles (lumens/square foot) or lux (lumens/square meter). One footcandle equals 10.76 lux, although for convenience the IESNA uses 10 lux as the equivalent.

Indirect lighting: Lighting by luminaires distributing 90 to 100 percent of the emitted light upward.

Instant-start: A method of starting fluorescent lamps in which the voltage that is applied across the electrodes to strike the electric arc is up to twice as high as it is with other starting methods. The higher voltage is necessary because the electrodes are not heated prior to starting. This method starts the lamps without flashing; it is more energy efficient than rapid or preheat starting, but results in greater wear on the electrodes during starting. The life of instant-start lamps that are switched on and off frequently may be reduced by as much as 25 percent relative to rapid-start operation. However, for longer burning cycles (such as 12 hours per start), there may be no difference in lamp life for different starting methods.

Glossary of terms

Lamp: A generic term for a man-made source of light.

Lens: A glass or plastic shield that covers the bottom of a luminaire to control the direction and brightness of the light it emits.

Light: Radiant energy that is capable of exciting the retina and producing a visual sensation.

Louver: A series of baffles used to shield a light source from view at certain angles or to absorb unwanted light. The baffles are usually arranged in a geometric pattern.

Lumen: The unit of measurement defining the output of a lamp. Could be said to measure a *volume* of light.

Luminaire efficiency: The ratio of the light emitted by a luminaire to the light emitted by the lamp or lamps within it. Components of a luminaire such as reflectors and diffusers absorb some of the light from the lamp(s). A highly efficient luminaire emits most of the light that the lamp(s) emits.

Luminous flux: The time rate of flow of light.

Lux (lx): A unit of illuminance. One lux is one lumen per square meter.

Matte surface: A surface from which the reflection is predominately diffuse, with or without a negligible specular component.

Offending zone: A lighting location that produces maximum veiling reflections.

Open plan office: An office space, divided by screened or panels that do not reach the ceiling, with desk layouts designed through a system planning process to produce a flexible office environment.

Portable lighting: Lighting from a fixture designed for manually portability.

Power factor: A measure of how effectively a ballast converts current and voltage into usable power to operate the lamps. A power factor of 0.9 or greater indicates a high power factor ballast.

Preheat: A method of starting fluorescent lamps in which the electrodes are heated before a switch opens to allow a starting voltage to be applied across the lamp. With preheat starting, the lamp flashes on and off for a few seconds before staying lit, because several starting attempts may be necessary to establish the electric arc across the lamp electrodes. Often, the luminaire's start button must be held down until the lamp lights. Preheat ballasts are less energy efficient than rapid-start or instant-start ballasts.

Prismatic lens: An optical component of a luminaire that is used to distribute the emitted light. It is usually a sheet of plastic with a pattern of pyramid-shaped refracting prisms on one side. Most ceiling-mounted luminaires in commercial buildings use prismatic lenses.

Quality of lighting: Pertains to the distribution of luminance in a visual environment. The term is used in a positive sense and implies that all luminances contribute favorably to visual performance, visual comfort, ease of seeing, safety, and aesthetics for the specific visual tasks involved.

Rapid-start: A method of starting fluorescent lamps in which the ballast supplies voltage to heat the lamp electrodes for 1 to 2 seconds prior to starting and, in most cases, during lamp operation. A rapid-start system starts smoothly, without flashing.

Reflected glare: Glare resulting from specular reflections of high luminances in polished or glossy surfaces in the field of view. It usually is associated with reflections from within a visual task or areas in close proximity to the region being viewed.

Reflection: A general term for the process by which the incident flux leaves a surface or medium from the incident side, without change in frequency.

Reflector: A device used to redirect the luminous flux from a source by the process of reflection.

Task lighting: Lighting directed to a specific surface or area that provides illumination for visual tasks.

Glossary of terms

Task-ambient lighting: A combination of task lighting and ambient lighting within an area such that the general level of ambient lighting is lower than and complementary to the task lighting.

Total harmonic distortion (THD): A measure of the degree to which a sinusoidal wave shape is distorted by harmonic wave forms, with higher values of THD indicating greater distortion. Electrical devices, such as computers and fluorescent lighting systems, can send harmonic wave forms at many frequencies back onto the power supply line, thereby distorting the current wave shape. For 4-foot lamps, the American National Standards Institute (ANSI) recommends a THD limit of 32 percent, but some electric utilities only provide financial incentives for ballasts that produce less than 20 percent THD. Ballasts that produce less than 10 percent THD are available for installations with critical power requirements.

Veiling luminance: A luminance superimposed on the retinal image which reduces its contrast. It is the veiling effect produced by bright sources or areas in the visual field that results in decreased visual performance and visibility.

Veiling reflection: A reflection of a light source that obscures task details by reducing the contrast between them and their background. Also known as reflected glare.

Visual performance: The quantitative assessment of the performance of the visual task, taking into consideration speed and accuracy.

Visual task: Conventionally designates those details and objects that must be seen for the performance of a given activity and includes the immediate background of the details or objects.